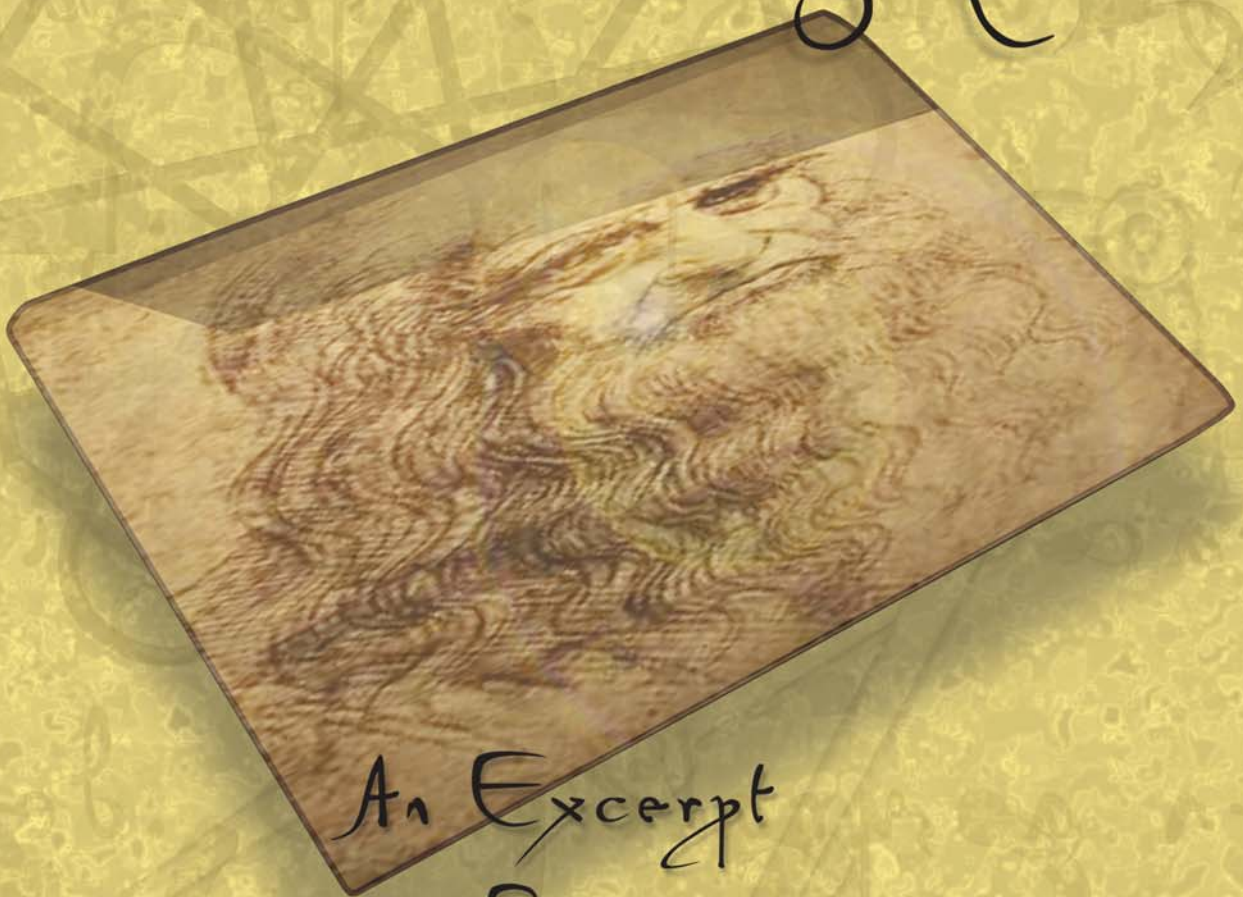


Understanding Human



An Excerpt
from
Leonardo's Laptop

By Ben Schneiderman

Illustration by Mark Wiener/David Goldman Agency

Activities and Relationships

“These notes reveal the intimate tie in Leonardo’s thinking between... phenomena in general and the need to put such information to practical use.”

— A. Richard Turner, *Inventing Leonardo*, 1994, p 184

Why do we use computers?

Human nature and needs were not changed by the invention of computers. People have always needed food, shelter and medical care and they always will. People also need, seek, and thrive on the emotional relationships with family, friends, neighbors, and colleagues. A nurturing parent and a caring friend will always be valued. Similarly, a neighbor’s cheerful assistance and a colleague’s supportive suggestion will enrich interdependence and strengthen trust. These human relationships grow when there is a shared history of positive experiences. The atmosphere of generalized reciprocity, the willingness to help others so that they will someday help you, smoothes the way for more ambitious cooperation and increases feelings of security.

When basic physical and emotional security are achieved, people then seek to establish commercial, political, and legal structures, and they contribute to these structures by their work and voluntary efforts. As civic structures are realized, people have growing amounts of leisure time and the security to get beyond basic needs. They can become creative in science, literature, music, and art and they enjoy participating in entertainment, games, hobbies, and sports.

When these needs and desires are fulfilled most people are satisfied. Having a good meal with your family and friends at a restaurant near your vacation home at a ski resort would make most people happy. But utopian images are only one side of human nature. Every positive can be linked to a potential negative: Food can contain carcinogens, houses consume energy, and resorts can

destroy the environment. And remember that every happy relationship can fail: Families can be torn apart, friends can become unscrupulous, neighbors can be deceptive, and colleagues can be competitive. Commercial firms can take advantage of customers, politicians can be corrupt, and legal systems can be manipulated. It can be a cruel world, but diligent planning can reduce the risks.

If technology developers start from an understanding of human needs, they are more likely to accelerate evolutionary development of useful technology. This belief is the basis for what I call the new computing, whose motto is: The old computing is about what computers can do; the new computing is about what people can do.

The new computing is about collaboration, empowerment, and creativity (www.cs.umd.edu/hcil/newcomputing). The payoff from a new computing innovation is that it supports some human needs while minimizing the downside risks. Therefore, responsible analyses of technology opportunities will consider positive and negative outcomes, thus amplifying the potential benefits to society. These themes were inherent in the work of social commentator and historian of technology, Lewis Mumford (1895-1990) who characterized the goal of technology with quiet simplicity: “to serve human needs.”¹ This straightforward phrase has been an inspiration for me, pushing me to construct concrete principles to guide my own use of technology. It has led me to a framework to help technology developers discover opportunities for innovation.

As I studied my own use of computers and informa-



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tion technologies, I found it easy to interpret my usage in terms of satisfying my needs. I use computers to support my relationships with family and friends, to teach my students, to organize conferences with other professionals, and to buy books from online stores. My activities include gathering information, collaborating with colleagues, designing interfaces, and distributing my ideas.

When I interviewed other people about their activities, they also reported that gathering information, communicating with acquaintances and colleagues, plus instant messaging to close friends and family were central to their daily use. These patterns were confirmed by a variety of user surveys by the U. S. Census Bureau, the Pew Center, UCLA and others.² More than 80 percent of Internet users emphasize information gathering (especially medical, travel, and entertainment) and email plus instant messaging. Most users of computers are not interested in the technology; they are focused on their own information needs and relationships.

Having chosen Leonardo da Vinci as my inspirational muse for shaping the new computing, I returned to his notes as a starting point in thinking about human needs. Sure enough, Leonardo had thought and written about what he characterized as the four prime human activities: mirth, weeping, contention, and work. This was an appealing starting point, as he addressed emotional states that emerge in personal and business relationships. I also thought about Leonardo's explicit integration of art and science in the service of practical purposes. The take away message reverberated in my head: Technical excellence must be in harmony with user needs. But I wondered what other potent statements of human needs could guide design of future information and communications technologies?

I sought historical sources such as the Ten Commandments (Thou shalt not kill, Thou

shalt not steal,...) and the Golden Rule "Do unto others as you would have them do unto you." These are inspiring principles that should be in the mind of every user and designer, but I wanted more refined guidance that was easily translatable into technology innovation.

Another source was Thomas Jefferson's characterization of universal human needs in the U.S. Declaration of Independence, which proclaimed "life, liberty and the pursuit of happiness." I agreed that these are admirable goals, but I was looking for something that I could easily tie to new technologies. I registered Jefferson's goals in my mind and continued my search.

A later U.S. President, Franklin Delano Roosevelt, gave his Four Freedoms speech to the U. S. Congress (January 6, 1941) in which he looked "forward to a world founded upon four essential human freedoms." Roosevelt sought freedom of speech and expression, freedom of religion, freedom from want (economics and health), and freedom from fear (especially reduction in armaments). These also laid out useful ideas that are important to keep in mind, but I was after a more detailed link to activities and relationships.

In the 1950s, psychologist Abraham Maslow proposed a hierarchy of human needs (Figure 1).³ He was writing at a time when psychoanalytic theory suggested that people were governed by subconscious motivations. He was also battling behaviorist's claims that people were merely stimulus-response machines and trying to shift researcher's attention away from abnormal behavior. Maslow spoke the refreshing language of "human potential" and described people as seeking creative expressions that enabled self-actualization. His early writings presented five levels of a hierarchy of human needs, building them up from the lowest level of survival needs to the highest level of fulfillment that he called "self-actualization":

¹ Mumford, Lewis, 1934. *Technics and Civilization*, Harcourt Brace and World, Inc., New York.

² An extensive Web site with multiple data sets is available at <http://webuse.umd.edu>

³ Maslow, Abraham, *Toward a Psychology of Being 2nd. ed.* New York, US Van Nostrand Reinhold, 1968. A thoughtful review of Maslow's ideas appears at www.ship.edu/~cgboeree/maslow.html

- 1) Physiological: Biological survival, food, water, air
- 2) Safety: Secure house, no physical threats
- 3) Love, Affection and Belongingness: Giving and receiving
- 4) Esteem: Self-respect and respect for others, generates self-confidence
- 5) Self-Actualization: fulfillment of what a person was "born to do" ...
 "A musician must make music, an artist must paint, and a poet must write."

These are appealing as they deal with dangers to be avoided and goals to be sought. Levels 1 and 5 apply to individual needs, while 2, 3 and 4 describe relationships with others.

This hierarchy appeals to me because it deals with an orderly spectrum of needs, is action-oriented, and focuses on relationships. I could begin to interpret how instant messaging or online communities support these needs. Maslow's hierarchy became an important guide to the new computing, but I was still eager to have a framework that made categories of relationships and precise activities more explicit.

My quest for clearer statements of human needs led me to Steven Covey's simple formula for life: Living, Loving, Learning, Leaving a Legacy.⁴ Living and Loving reiterate Maslow's Levels 1 through 4, while Covey's Learning and Leaving a Legacy expand on Level 5. It is brief and punchy, yet thoughtful and compelling. Covey's expansion deals with setting goals by writing a personal vision statement ("begin with the end in mind"), then choosing directions

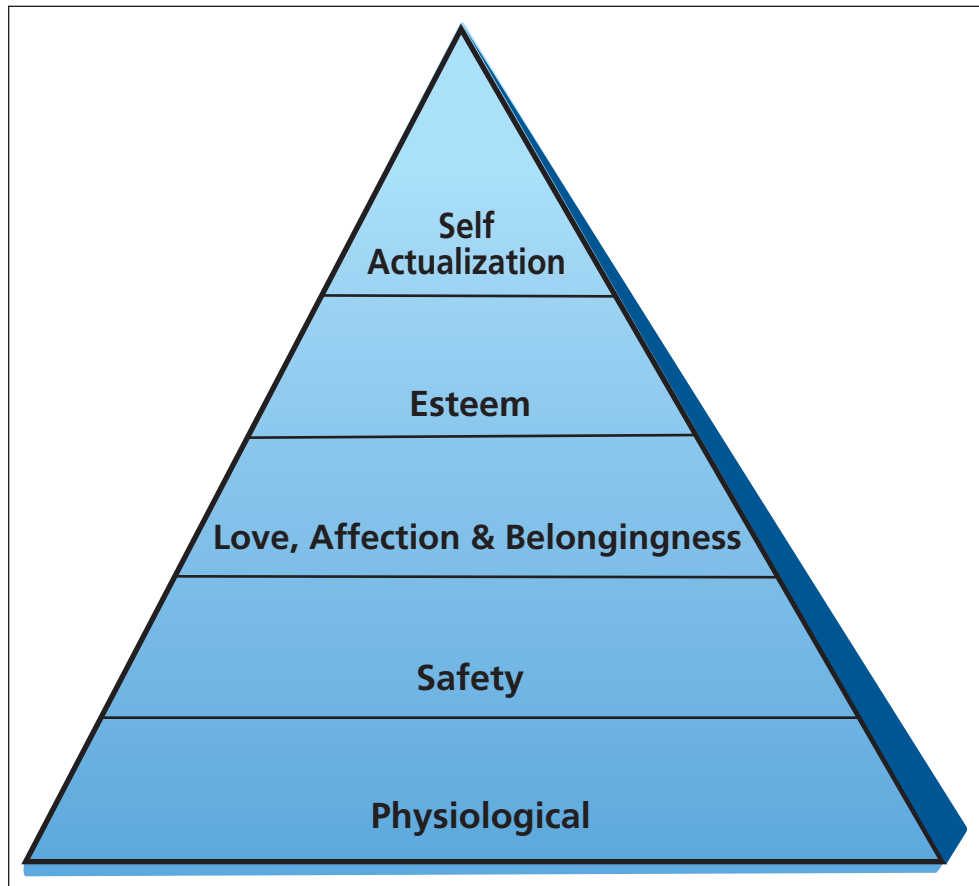


Figure 1: Maslow's hierarchy of human needs

carefully. He pushes down to specifics such as time management, empathic communication, and measuring progress. I also found that his descriptions of independence, dependence, and interdependence were effective in making explicit the multiple aspects of human relationships.

These philosophical statements are all helpful in shifting attention to universal human needs. They do set out important goals, but coming up with a framework to help technology developers seems to require an integrated activity-oriented approach that also identifies relationships—who does what with whom.

Four circles of relationships

In my quest to develop a framework for technology innovation I focused directly on growing circles of human relationships. In the old computing, computer usage was

⁴ Covey, S. R., Merrill, A.R., Merrill, R. J. R., 1994. *First Things First: To Live, to Love, to Learn, to Leave a Legacy*. Simon & Schuster Publishing, New York.

usually defined as a solitary experience, a concept that was encouraged by the term "personal computer." But turning outward to focus on relationships led me to a fresh place where "family computer," "corporate community" or "civic network" might be appropriate terms.

The first circle at the center is still your personal use of the computer (Figure 2). You may just want to listen to music, read the news, or write in your diary. This is the private sphere, in which you are safe,

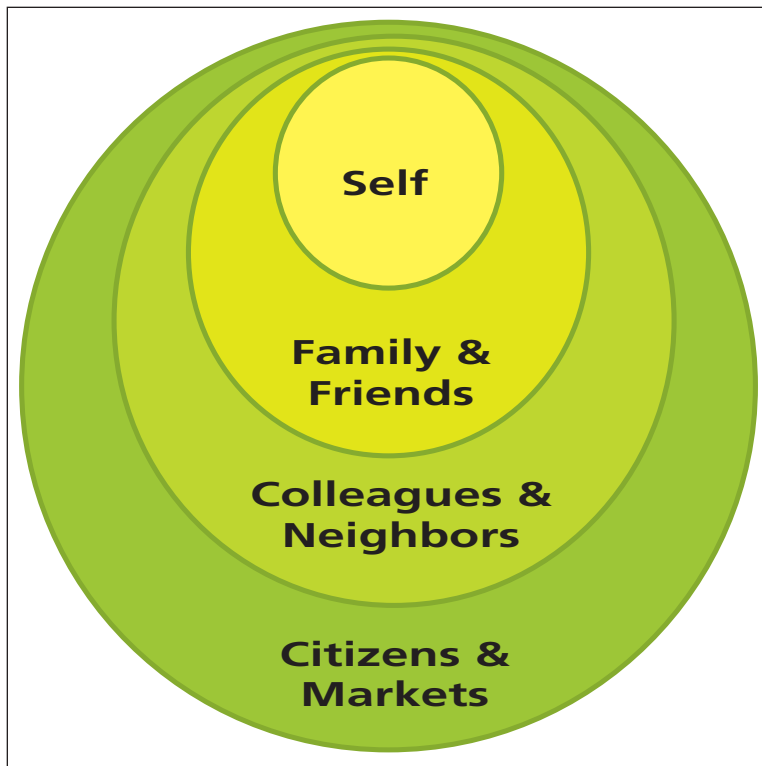


Figure 2: Circles of relationship

secure, private, and free to create what you wish to satisfy your personal whims.

The second circle includes your enduring relationships with small numbers of trusted family or friends (2 to 50 people) with whom you have much shared knowledge and high expectations of meeting regularly. You've been cared for by your uncles and aunts, played with your cousins and friends, and gone to school with these trusted classmates. They know a lot about you and they would do a lot for you. You would trust them with your money, car, and emotions.

The third circle is much larger and

includes the changing sets of professional colleagues or neighbors (50 to 5,000 people) who are moderately trusted, who share common interests, and who you expect to meet again. They might be members of your professional society or residents of your city, county, or state. You have a lower level of trust, but share some common knowledge. You may not know other professionals or residents until introduced for a specific activity, but if they do the same work or live in the same neighborhood, you have lots to talk about.

Finally, the fourth and largest circle is defined by the citizens of a country or participants in a market (5,000 and more people). Your trust is low for them, your shared experiences may be few, and your economic situation may be different. Participants in a market, such as eBay or teenage music fans on MTV (Music Television), have some common ground, shared knowledge, and accepted social norms, but the risk of surprises is greater. eBay regulars know about the latest policy changes and they depend on the reputation manager to establish trust, but they are wary of each deal. Similarly, MTV fans share common knowledge of the latest music hits and fashion trends, but don't leave their valuables in the open on the dance floor.

These four growing circles of relationships are characterized by size differences and the degree of interdependence, shared knowledge and trust. It is an imperfect separation with fuzzy boundaries and boundary breakers, but serves to identify current and potentially winning technology innovations. Buddy lists are for the intimate friends and family, while message boards and distribution lists work for colleagues and neighbors. Support for larger groups such as novel Web strategies are emerging to enable relationships among millions of people who are citizens of a country or participants in a market. eBay, NASDAQ, and Amazon are examples of million-person online communities, although critics will argue about their boundedness and cohesion.⁵

Focusing on relationships is a new direction for many people in the computing field.

After all, the basic notion of the personal computer was tied to the high degree of introversion among information processing professionals. They usually prefer to be in their personal workspace and believe that working alone is the fastest way to make progress, even if they could sometimes be more productive by cooperating with others.

It is not surprising that most software was designed for individual use, but as new personality types began using computers their needs prompted the emergence of groupware and research on computer-supported collaborative work. As these new needs for cooperation appeared, new software and user interfaces were invented to provide appropriate communication. Of course, solitary work will always be necessary and group work has its problems. Many groups get into trouble, leading to spectacular controversies that trouble managers and participants. By contrast, individual failures tend to be more quietly covered over so that their damage is not noticed.

As a user, you might consider your balance of solitary and group work. Are there ways that you could use information and communications technologies to support your solitary work and to participate in the three larger circles of relationships? As a technology developer, could your innovation have multiple versions that were suited for solitary work, or to support relationships in small, medium, and large groups?

As you shift your balance between solitary and group work, the benefits and dangers of each should be on your mind. Working alone frees you from interdependence, but means you have only your own skills and knowledge to rely on. Working with others requires extra effort to build a trusting relationship, but you can share work and benefit from complementary skills and knowledge or simply split the effort to speed completion. Each approach has its satisfactions and frustrations, but drawing on both can provide the most productive and satisfying outcomes.

Four stages of activities

The four circles of relationships are one dimension of my framework to accelerate technology innovations. A second dimension is needed to separate out the stages of activities that users participate in. One approach would be lifecycle events such as birth, adolescence, marriage, retirement, etc. This is generative of new applications and Web sites, such as services to help new parents, teens in trouble, or wedding planners. A lifecycle approach is helpful, but many important aspects of life happen between these memorable events. Another interesting approach is the rhythm of daily, weekly, or annual activities, so we'll save these for later refinements.

A better choice for an activity spectrum comes from studies of creativity. The first step in a creative process, often called preparation, involves collecting information—just what today's Web supports quite well. In fact "information technology" has become the generic label for much of technology. But rather than focusing on how many gigabytes or pages of information are available (the old computing), we'll focus on the user's activity of collecting information (the new computing).

The responsibility for success in the information collection activity resides with the user. Users may *collect* information from family and friends who are likely to offer what they know easily during a visit or phone call. The next circle of contacts includes colleagues and neighbors who may be responsive to an email because of their expectation of reciprocity in their future information needs. Institutions such as professional societies, local government, corporations, universities, museums, and libraries offer informational Web sites that contain vast resources as part of their membership services, for a fee, or as a natural part of their institutional commitment. National resources such as the U.S. Library of Congress⁶ or the British Library and marketplace databases such as ebay or Amazon

⁵ eBay www.ebay.com
The Nasdaq Stock Market, Inc. www.nasdaq.com
Amazon www.amazon.com

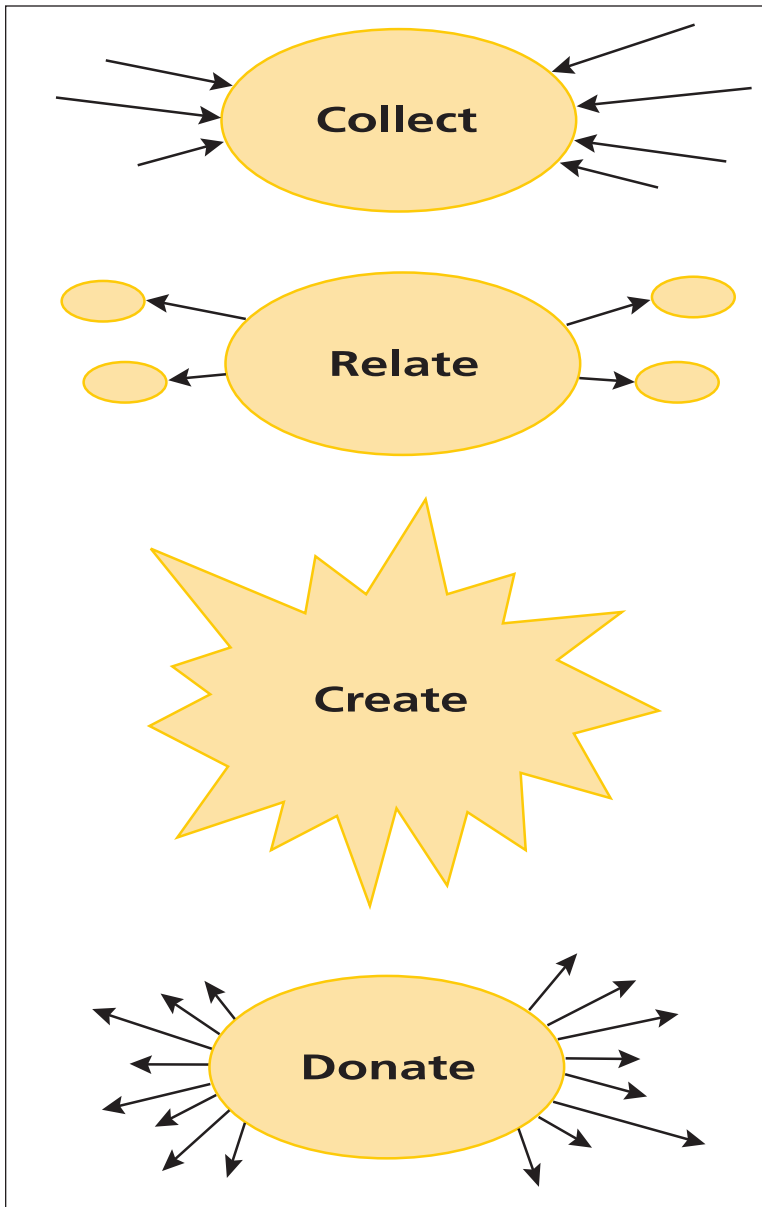


Figure 3: Four stages of human activities: Collect-Relate-Create-Donate

serve broad audiences. Users often have serious intentions related to shopping, but there's great fun in checking eBay to see the price grandma's crystal glassware is getting or reading reviews on Amazon. Similarly financial markets such as Nasdaq or the New York Stock Exchange generate vigorous enterprises, such as Fidelity, Smartmoney, and Charles Schwab, which provide voluminous information ready for collecting by consumers and professionals.⁷

Collecting information is the usual first stage of activity, and users may return to this activity repeatedly (Figure 3). A second vital stage of activity involves relationships with others. The *relate* activity, consultation with peers or mentors, may occur in the early, middle, or late phases of a project. Relationships are so powerful an attraction that telegraphs, telephones, email, and instant messaging grew rapidly and spread widely. Entrepreneurs quickly realized that the market was strong for "communications technology." The thirst for relationships by phone and email is so powerful that many people carry communications gadgets everywhere and spend large amounts of money for services.

By now information (collect) and communications (relate) technologies are booming, so it is natural to ask what might be the next revolution. Leonardo now returns as the inspirational muse, because he reminds us of the strong urge to create. A broad interpretation of the *create* activity includes composing a song, planning a birthday party, launching a business, or organizing a social movement. So maybe the next revolution, following information technology and communications technology, is in "innovation technology." This third revolution has already begun and shrewd users and designers have already found the power inherent in creativity support tools.

The fourth stage of human activity is what Maslow referred to as self-actualization and what Steven Covey called "Leaving a Legacy." I'll use the term *donate* to complete the sequence with a rhyming scheme: collect-relate-create-donate. The *donate* activity covers giving to yourself, to your family, to your profession, to your community, or to your country. This is most visible in acts such as helping to care for friends and family, volunteering to help care for elders in a community center, or giving to national charities such as the Red Cross.

The concept of donation is also tied to

⁶ U. S. Library of Congress www.loc.gov

⁷ New York Stock Exchange www.nyse.com

Fidelity Investments www.fidelity.com

Smartmoney www.smartmoney.com

dissemination of creative products. Composers of songs want to do more than write a great song, they often want distribution to and appreciation by others. Business leaders often talk about the desire to create value and develop successful businesses that change people's lives. Inventors want patents and royalties, while scientists want publications and citations. The desire for broad recognition and 15-minutes of fame is widespread.

These four stages of human activity are not a complete representation of life, but they may help you by suggesting new ideas for accomplishing your goals. For example, you may think of shopping as merely finding the best price for your next car. But you could decompose shopping into collecting information about products, their features, and uses. Then you might work on forming a relationship with the seller, put some thought into creating the deal, and then offer to be a positive reference for the seller. This could make you a more effective shopper, and it might be more satisfying to you and the seller.

Similarly, you might rethink how you participate in sports or plan your next vacation in terms of learning more about the game or destination, building relationships along the way, creating something novel, and spreading the word about what you have done. The collect-relate-create-donate rhythm of activities may suggest new ways of thinking about old problems.

An Activities and Relationships Table (ART)

You've probably guessed where this discussion is leading. The four circles of relationships combine neatly with the four stages of activities to make a two-dimensional grid: an activities and relationships table (ART) (Figure 4). This table shows what activities you can accomplish with members of each circle of relationship using one of the technologies: information, communication, innovation, and dissemination. It's not perfect, but it may help you, as a computer user, to solve some of your problems in fresh ways. It may help technology developers in

spotting new opportunities.

For example, if you are moving into a new neighborhood and need to find a doctor, your first step might be to collect information (first column of ART). Recommendations from family and friends would be a great starting point, because you trust their comments. They know that you need a physician to take care of your two young

The four stages of human activity are not a complete representation of life, but they may help you by suggesting new ideas for accomplishing your goals.

children and a physician who is good in dealing with your asthma and your spouse's high blood pressure. You could ask your new neighbors but you might be cautious since they may not know enough about your preferences or needs in medical care. You could try to track down listings of local physicians or local agencies that make recommendations, but you are likely to assume that these recommendations are biased or insufficiently tuned to your needs. Finally, you could consult national medical directories that list physicians by region and specialty, but this is generic information that is only a starting point for further inquiries.

Your second step would be to contact local doctors or health care organizations, describing your needs and asking for references so you could communicate with current patients (second column of ART). References and testimonials can be an important part in building trust in new relationships. You might even contact medical review boards or state agencies to get details on performance of specialists or

A R T	Collect Information Read documents Listen to stories Explore libraries Learn customs	Relate Communications Ask questions Join meetings Participate in dialog & reciprocity Develop trust & unity	Create Innovation Compose, write, sketch, build, make Brainstorm & visualize Make plans & policies Explore alternatives Simulate outcomes	Donate Dissemination Write reports, record history Tell stories, publish insights Organize events Advise and lead Care, train, mentor
Self (working on your own)				
Family & Friends (2-50 close intimates)				
Colleagues & Neighbors (50-5,000 regular encounters)				
Citizens & Markets (5,000 and more)				

Figure 4: An Activities and Relationship Table (ART)

health care organizations.

If you've been especially diligent, you might organize all your information, ranking candidates by key attributes such as quality of care, cost, and convenience. If you were a truly devoted community activist, you could apply your creative energy to construct a small handbook for newcomers to your neighborhood that records your information (third column of ART). Then you could help others by disseminating (donating) your information through a posting to a community Web site (fourth column of ART). The *donate* activity leads to creation of ever larger libraries of information that are the sources from which others can begin their collection process.

The new computing as mapped by an Activities and Relationship Table could also be an opportunity for technology developers to invent software tools or services to organize and speed the process of choosing a physician. Spin-off ideas such as discus-

sion groups among patients of specific doctors or among patients with specific diseases expand the possibilities. More ambitious opportunities to compare physician performance within regions or nationally become possible, as well as research to improve the quality of patient care.

This scenario portrays a diligent, motivated, and resourceful person who has the knowledge and time to find the right physician for his/her family. You might not be so dedicated, but you may find other ways to create a satisfying social community or create something for your family or colleagues. Most people want to have friends invite them to go jogging and live in a community where neighbors happily care for your children. Unfortunately, increased time pressures, longer commutes, higher expectations, and even growing use of the Internet can undermine your ability and willingness to give generously. But you can just as easily put greater emphasis on

human needs and your community. You can use the new computing to restore the lost social capital.⁸

Many other everyday challenges that you face such as finding a home to live in, starting a business, or getting a new job could be facilitated by thinking about the circles of relationships and following the collect-relate-create-donate stages of activities.

For technology developers, the Activities and Relationships Table might suggest new tools and services. The remainder of this excerpt offers two cases studies of interface innovations that were fostered by thinking of the Activities and Relationships Table. The rows and columns are not sharply defined and many activities will fit in several cells of this table. Imperfections and omissions are easy to find, but the goal of this table is to provide provocative inspiration.

Mobility and ubiquity: PalmTops, FingerTips, InfoDoors, WebBushes

As a case study, let's apply an Activities and Relationship Table to the strong desires of many users for mobile and ubiquitous access, anywhere and anytime (Figure 5). The success of portable devices from the venerable transistor radio to the cherished Walkman cassette tape player to the amazing MP3 digital music players demonstrate the strong desire consumers have for music on the go. The same users, who want big screens and impressive desktop machines in their offices and home, also want small portable devices to carry with them everywhere. They want big screens for viewing maps and designing houses, and small screens for stock prices, weather reports, and flight information anywhere, anytime. Leonardo was just the same, sometimes working with wall-sized frescoes and large portraits, but he also had many small notepads everywhere. He was a scribbler, a doodler, who took his notepads everywhere.

Recognizing the desire for mobility, the designers of the 1990s started to produce small devices. The Palm and the Psion demonstrated that technophiles would use well-designed portable information tools—true information at your fingertips.⁹ At the same time, the exploding growth of cell phones exposed the intense desire for communications. By the early 2000s the combinations became irresistible: wireless communications for palm-sized devices and bigger displays for cell phones.

The Palm designers brilliantly focused on a few portable information needs: calendar, address book, to-do list, and a notepad. The surprise here was that users were willing to learn a variant of the English alphabet, called graffiti, so that they could do data entry with a few quick strokes for each character. The surprise is even greater in light of the failure of the Apple Newton that offered recognition for handwritten words. Apparently most users get greater satisfaction and utility from entering many easily recognized small strokes than a few often mis-recognized handwritten words. Many users are willing to learn a new alphabet if it enables reliable data entry. Most users feel responsible for graffiti stroke recognition errors while tending to blame the Newton for word recognition failures. This may be because the locality and cause of errors is clearer in graffiti, making it easier to go back and get it right.

Palm add-ons such as games and restaurant guides appeared quickly, and now e-books and news headlines are growing applications as screen sizes grow and readability improves. In parallel, cell phone designers created a surprising willingness for users to enter short emails on the telephone keypad. Soon enough millions of young users shifted from talking to texting. Here again mastering a new skill seems to have engaged many young users. The motto for the yellow pages directories was to

⁸ I've been profoundly influenced by Putnam, Robert, 2000. *Bowling Alone: The Collapse and Revival of American Community*, Simon & Schuster, New York. His analysis of the decline since 1965 of "social capital" is a brilliant analysis of how and why Americans have reduced their participation in community groups and political activities. He even demonstrates reduced participation in picnics and dinner parties. The explanations and documentation of harm are disturbing.

⁹ Bergman, Eric (Editor), 2000. *Information Appliances and Beyond*, Morgan Kaufmann Publishers, San Francisco.

“let your fingers do the walking” but with cellphone data entry you let your fingers do the talking.

The Palm wins on-screen readability making it likely to grow as an information resource beyond news, calendars, or navigation. The cellphone wins on commercial viability because it is already tied to a pay-for-service mentality, making it natural to spend money by phone. Not only will you be able to buy stocks or airline tickets by cell

mentation process. Wristwatch devices can already contain cameras or calendars and other technologies will be embedded in shoes, bracelets, necklaces, rings, and clothing. Some will facilitate information gathering such as exchanging contact information, or be part of commercial activities such as payment processes, or collect medical information. Here again, visionary insights come from thinking more about human needs than technology possibilities.

A R T	Collect Information	Relate Communications	Create Innovation	Donate Dissemination
Self	Flight info Weather		Diary	
Family & Friends	Address lists	Find-a-friend E-postcards	Music playlist	Family vacation histories
Colleagues & Neighbors	InfoDoors GatherEmail	Send-a-Link InfoDoors	E-guestbooks	
Citizens & Markets	Stock quotes WebBushes	Click-n-pay	E-guestbooks	Napster for tourist info

Figure 5: An Activities and Relationship Table partially filled in for mobile and ubiquitous applications.

phone, but many little simplicities seem likely to appear. Why not pay for your parking or can of Coke by cell phone. As you park your car, just key in the code number pasted on the meter and a dollar gets charged to your phone bill. As you stand in front of a soda machine, just scan the code number pasted on the soda machine and “You are on your way with Click-n-pay!”

But these devices are just the beginning of the miniaturization and pervasive imple-

The exchange of business cards is a delightful tradition that has acquired some appealing rituals, such as the formal Japanese offering process or the playful style of tossing them across a conference table. Palm users make a game out of their infra-red beaming to send contact information. But imagine you want to gather the email addresses of the fifty people at a meeting in order to send them a message. The Palm solution of beaming one contact

at a time is much too slow and still makes it tedious to collect all the email addresses into the header of a message. Recognizing the need for a GatherEmail tool is the first step, and then a dozen different technologies could be applied to solve the problem.

Other devices are likely to become fads. Lapel pins or earrings might become the information exchange devices with 10,000 names stored in shoulder pads or belt buckles. Other FingerTip applications would be to have rings, bracelets, or batons to operate devices around you. Imagine a ring that could be rotated to dim the lights of any room you were in, lower the air conditioning, or turn the sound volume up on the TV or radio. Maybe a bracelet that detected gestures would do the job, such as making a fist to turn the lights off or raising your finger from the stereo to the ceiling to raise the sound.

I've often wanted information services when traveling. Imagine that as you board an airplane you could check out if anyone else from your company or alumni of your college was on board, or more practically if anyone else was going to the Hilton Hotel so you could share the long taxi ride. These possibilities become viable as information access becomes widespread, but user control over privacy will become a growing concern. As I visit a new city, especially if I am wandering around on my own, I wish for a radar-like device—Find-a-Friend—that would let me identify friends who might be nearby to recommend a restaurant or show me around.

An extension of these ideas is that when attending a business presentation, you automatically get the copies of the speaker's slides on your laptop—Slides-to-Go. This can be done by a wireless transmission (radio waves or infra-red signal) of the file or simply its Web address—Send-a-Link. You could walk out of the meeting with the slides, the minutes, and the list of actions items on your laptop or easily accessible from the Web.

But portable devices are only one manifestation of the intense desire for personal information and communications services.

Moving to lower rows on the Activities and Relationship Table, suggests that information tools that reach friends, neighbors and colleagues might present opportunities for developers. Let's follow one more idea in depth, before we fill in the Table.

Look at your office door at work. It probably has a nameplate in a wood or metal frame, giving the room number plus your name and title. If you move then your nameplate gets replaced. Often your door acquires additional notes with schedule information, referrals for assistance, or a photo. Office doors often become a resting place for post-it notes with messages such as "Out to lunch, be back at 2 P.M." or "look for me in the kitchen." Travel plans such as "I'm in New York till Thursday" or "Vacationing in Paris till Labor Day" also wind up on many office doors.

Imagine mounting a Palm display on your office door with an internet connection (wired or wireless). Voila—the InfoDoor! The InfoDoor is an information appliance located at your doorway providing practical services such as personal scheduling, weather reports, or organizational announcements. It would have an Internet connection and a touchscreen surface mounted at eye level on or near the doorway to your office, linked to a server in the building. The InfoDoor would have an important role in emergencies, when it could steer you to safe exits in case of fires, toxic gases, or earthquakes. The lifesaving aspect of InfoDoors may justify their installation, but clever users will undoubtedly find other applications that are compelling or just plain fun, such as posting cartoons or personal photos.

A typical office building might have hundreds or thousands of InfoDoors. If bought in bulk and installed during construction the price will soon be less than a hundred dollars per unit. The flexibility and openness for future growth should be appealing for smart building promoters. Normal operation is quiet mode, in which the InfoDoor displays your name, title or other standard information, but it could be changed to include a quotation or joke of the day.

You could send a message to the InfoDoor to indicate that you are late for a meeting and you could provide information or instructions, e.g. "I'll be in by 10:30 A.M., meanwhile please see Judy at the front desk." If you post a schedule, then a visitor could select free times for a visit. If you are in a meeting, then you could post a note saying "Please do not disturb till noon" and encourage visitors to select a later time for a visit.

If you are not in your office or you are busy, the InfoDoor could provide referral information to appropriate providers, e.g. "For assistance till noon, see my secretary in room 472. To pick up a job application go to room 532, for information on available jobs touch here."

Doorways are often used to post personal information, newspaper articles, birth announcements, baby pictures, and many other personalized touches. This form of self-promotion, self-expression, entertainment, and personal publication may be one of the big attractions of the InfoDoor.

You or the management could post announcements of time-sensitive events in the building such as lectures, meetings, visitors, blood donation drives, charity programs, flu injections, and holiday gift sales. Other announcements could include weather reports such as snow emergencies, hot weather warnings, and air-conditioning or heating changes. Traffic accidents, crime alerts or early office closings could also be posted. Some of these can be sent by email, but sending them to the InfoDoor gets them off of email and enables them to be publicly available in familiar places.

Fire alarms or emergency messages could be sent with a warning tone. The messages could be more specific than current fire alarm systems and could direct people to the nearest safe exit, while guiding fire fighters to the fire sources. InfoDoor alarms may satisfy emergency needs for rapid information during earthquakes, floods, toxic releases in industrial sites, explosions, or hostage situations in banks.

InfoDoors in office buildings, hotels, or homes are only one manifestation of ubiquity. Even in natural surroundings there are

interesting opportunities to sprout new information, communication, innovation, and dissemination portals. I'll call these WebBushes. While every rock and tree might become the site for a new display device, let's explore a simpler approach of merely labeling with barcode or small responder attached to any distinctive object. This would make it possible for you to point your PalmPilot at a palm tree and find out what kind it was, what its medicinal properties were, how it is used, and other bits of environmental, cultural, scientific, or historical information.

As you are rafting down the Colorado, you pass some striking sedimentary rock face and you click to find out what kind of geologic formation you are seeing, who first charted the upcoming rapids, and when the river crests in spring. In-depth information about the location, its cultural importance, and tribal histories could all be available for the interested reader. Each palm tree and river rapid would also have an associated Web site, so that as you travel, your portable device accumulates the sequence of URLs that define your journey. Then when you return home you can always retrace your steps, since you have a permanent record of where you were.

Text information is only a starting point for WebBushes, each palm tree or river rapid could also be the basis for a photo database of professional photos in every season and through history. Visitors could leave their written experiences or photos for their future reference or for others to see, possibly for a fee. They could dispatch e-postcards from memorable places and include photos from the here-and-now to connect with those who are far away.

Museum or hotel guest books are other precedents that could be expanded in many tourist and natural locations. E-guestbooks elicit user stories and encourage creative reporting that could enhance the experience for the teller and the recipient

Electronic guide books—e-guidebooks—are other opportunities for information collection and innovation. Think about riding along the Lewis & Clark trail from Missouri

to Washington State, biking the 184-mile Chesapeake & Ohio Canal, or walking the Appalachian Trail from Georgia to Maine. At each rest area you could follow your interests and download onto your portable device the information about the next section of the trail. You could upload your sunset photos or add your observations of a rare heron. Some might argue that the media distract from the natural experience, but they can intensify it as well by making visitors more aware of local birds, plants, or history. Not everyone wants to read the experiences of earlier visitors or leave their own comments, but enough people seem to enjoy such exchanges.

Specialized information also spawns niche audiences. Guides for parents with kids, disabled tourists, amateur archaeologists, and so on extrapolate existing trends in guidebooks and other information sources. Following the footsteps of frontiersman Davy Crockett or the residences of Leonardo may be specialized desires, but such individualized experiences give many people great satisfaction and a good story to tell when they get home. Registering at each destination and then having access to photos may be as much fun as visitors get at Disney's EPCOT when they stamp their passports at each country's pavilion.

The version of our Activities and Relationship Table can now be partially filled in with these ideas. But these are just the beginning. By now you may have your own inventions and ideas for new products or services that could benefit yourself, your family, your colleagues, or wider circles of

users. You may find new ways to contribute to the new computing—serving human needs for information, communications, innovation or dissemination.

The skeptic's corner

The Activities and Relationship Table is not as neat as Mendeleyev's periodic table of chemical elements. Human activities and relationships are more fluid than puddles of mercury and harder to contain than clouds of hydrogen. The ART is easy to complain about, incomplete, and too vague. But it does help shift the discussion from technology to human needs. It helps me think of whom I interact with and what I want to do in my life. It's not easy to make this shift in thinking, especially for those with technology-centered backgrounds, but putting user needs first is the key to the new computing.

You may be skeptical about some of my proposed InfoDoors or WebBushes. These are exploratory fantasies that may seem far-fetched or they may send you to work writing a business plan to seek venture capital funding. If I've provoked you to do better, that will be an even happier outcome.

You may also challenge the fundamental idea that human needs should guide technology development. I've put this forward as a central thesis, even while I am aware of the enormous temptation, great power, and fun of thinking about technology first. Maybe I haven't won you over completely, but I hope that you will think about your and other's needs more often as you apply and design new technologies. @

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Ben Shneiderman's Leonardo's Laptop: Human Needs and the New Computing Technologies will be published by MIT Press in October, 2002.